

SPECIAL SECTION: HEALTH CARE EPIDEMIOLOGY

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Replace Hand Washing with Use of a Waterless Alcohol Hand Rub?

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Hand hygiene is one of the basic components of any infection control program and is frequently considered synonymous with hand washing. However, health care workers frequently do not wash their hands, and compliance rarely exceeds 40%. Hand rubbing with a waterless, alcohol-based rub-in cleanser is commonly used in many European countries instead of hand washing. Scientific evidence and ease of use support employment of a hand rub for routine hand hygiene. It is microbiologically more effective *in vitro* and *in vivo*, it saves time, and preliminary data demonstrate better compliance than with hand washing. Therefore, a task force comprising experts from the Centers for Disease Control and Prevention and from professional societies is designing guidelines for the use of a hand rub in the United States. Today, most countries of Northern Europe recommend a hand rub for hand hygiene unless the hands are visibly soiled. Side effects are rare and are mainly related to dryness of the skin. This review evaluates the scientific and clinical evidence that support the use of alcohol-based hand rubs in health care facilities as a new option for hand hygiene.

Hand Hygiene in the Health Care Setting

Hand hygiene (figure 1) is the single most important factor in preventing nosocomial infections. It prevents transmission of pathogens by contact and the fecal-oral route [1], and its effectiveness has recently been reviewed by Larson [2]. It is usually classified as part of the general hand hygiene that is used on wards and that of the surgical team before an intervention. This review covers general hand hygiene but not issues associated with the surgical scrub.

The principles of hand washing are based on the work of Semmelweis, a pioneer in this field. In 1847, Semmelweis was head of the Vienna Lying-In Women's Hospital. It was divided into hospital I, where physicians and students provided care to the women in labor, and hospital II, where midwives were responsible for delivering the babies. Peripartum mortality in hospital I was up to 18%, compared with only 3% in hospital II [3]. At that time, bacteria were unknown to be a cause of infection, and "miasma"—bad air—was considered a possible reason for sepsis. Students performed autopsies with their bare

hands on nonrefrigerated bodies before examining women in labor.

Semmelweis instituted hand washing with nonmedicated soap as a mandatory measure before examination of women in labor. Mortality subsequently decreased from 18% to 3%, similar to the rate with midwives. However, Semmelweis still observed deaths due to sepsis. His introduction of hand washing with 4% chlorinated lime solution stopped the epidemic. Since epidemiological evidence today must always be supported by microbiological data, Rotter et al. [4] (150 years after Semmelweis) in 1997 tested the 4% chlorinated lime against the new European Norm EN 1499 and 1500 standards (discussed below) established for the testing of hand-washing agents and hand rubs, respectively. These tests involve artificial contamination of hands with *Escherichia coli* and determine the reduction factor before and after use of a soap or rub.

The antimicrobial efficacy is determined by calculating the difference in \log_{10} cfu before and after washing or use of the hand rub. The \log_{10} cfu reduction factor was 3.2 \log_{10} cfu for medicated soap and 6.1 \log_{10} cfu for chlorinated lime. These findings suggest that the superior efficacy of chlorinated lime resulted in a lower rate of nosocomial infection than with use of the soap alone. Even a hand rub with an alcoholic compound is still inferior to the chlorinated lime used by Semmelweis. Therefore, Semmelweis should be considered the pioneer of hand washing with a highly active disinfectant and not, as frequently stated, of hand washing with nonmedicated soap. Chlorinated lime is harmful to the skin and cannot be recommended for routine use. In addition, one may expect lower inocula on

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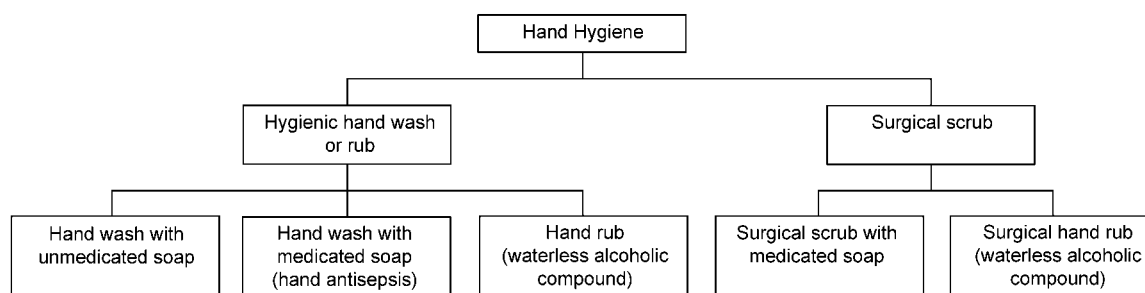


Figure 1. Classification of hand hygiene procedures

the skin of today's health care workers (HCWs) than on the hands of physicians treating patients after autopsies. Therefore, the antimicrobial efficacy of killing $>6 \log_{10}$ cfu may be unnecessary to prevent cross-transmission.

The value of relative reductions as a risk factor for subsequently transmitting pathogens remains unknown. Six studies and decades of experience have provided ample evidence of the effectiveness of hand hygiene for preventing cross-transmission. However, journals continue to publish reports of outbreaks of disease transmitted by contaminated hands, which suggest that the current recommendations for hand hygiene are not always followed. Therefore, new options are needed to further improve efforts to prevent cross-transmission by contaminated hands. Established indications for hand hygiene have been summarized in guidelines published by the Centers for Disease Control and Prevention (CDC) [1], which call for hand washing (1) before performing invasive procedures; (2) before taking care of particularly susceptible patients; (3) before and after touching wounds, whether surgical, traumatic, or associated with an invasive device; (4) after situations during which microbial contamination of hands is likely to occur; (5) after touching inanimate sources that are likely to be contaminated with virulent or epidemiologically important microorganisms; (6) after taking care of an infected patient or one who is likely to be colonized with microorganisms of special clinical or epidemiological significance; and (7) between contacts with different patients in high-risk units.

This article reviews the basic principles of hand hygiene and focuses on the advantages of a hand rub with an alcoholic compound versus hand washing.

Microorganisms on the Hands of HCWs

The density of bacteria on normal human skin ranges from 10^2 to 10^3 cfu/cm². These bacteria may limit colonization with more pathogenic microorganisms, just as fatty acids have antimicrobial efficacy [5]. HCWs can acquire pathogens from patients during their daily work and transmit them to susceptible patients. Multiple epidemics have been traced to contaminated hands of HCWs [6–8]. Most of the transient flora is found on

the uppermost level of the stratum corneum. HCWs' hands are frequently contaminated by direct contact while caring for a patient or while touching a contaminated surface or device.

Several studies have indicated that the hands of HCWs may be colonized or contaminated with pathogens, such as *Staphylococcus aureus* [9, 10], *Klebsiella pneumoniae*, *Acinetobacter* species, *Enterobacter* species, or *Candida* species. In addition, Pittet et al. [11] demonstrated that microorganisms accumulate on HCWs' hands over time during patient care. Therefore, hands of HCWs can transmit pathogens even without previous contact with other patients. Even using gloves does not completely protect against contamination of the hands. Doebbeling et al. [12] put different microorganisms on gloved hands; they were able to isolate the same microorganisms on the skin after removal of the gloves that were placed on the gloved hands. Therefore, hand hygiene is still necessary after the use of gloves.

Definition and Description of Terms

Terms dealing with hand washing are not uniformly defined all over the world. Therefore, this review includes definitions that are adapted from the guidelines published by the CDC and the Association of Practitioners in Infection Control (APIC) [13]. The microbiological flora on the normal human skin is colonized with multiple species of microorganisms. There are microorganisms found on almost everybody's skin, as well as bacteria picked up from the environment or from patients. Price [14] proposed a clinical classification of skin microorganisms on hands: the transient flora and the resident flora (table 1). This classification is also part of the recommendation by the APIC [13].

Transient flora. "Transient flora are microorganisms isolated from the skin but not demonstrated to be consistently present in the majority of persons" [13]. Such flora generally are considered to be transient but are of concern because of ready transmission by hands, unless they are removed by mechanical friction by washing with soap and water or destroyed by the application of a hand rub (table 1). Bacteria belonging to the transient flora are responsible for outbreaks related to contaminated hands of HCWs. Long-term reduction is not de-

Table 1. Clinical classification of skin bacteria.

Classification	Origin of microorganisms	Typical examples	Method of removal of microorganisms	Goal of hygienic hand washing	Goal of surgical hand washing
Transient flora	Contact with patient or environment	<i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , or gram-negative rods	Hygienic hand washing or hygienic hand disinfection	Elimination of transient flora	Elimination of transient flora
Resident flora	Permanent microorganisms of the skin	<i>Propionibacterium</i> species, <i>Corynebacterium</i> species, coagulase-negative staphylococci, or occasional gram-negative microorganisms (e.g., <i>Acinetobacter</i> species)	Surgical scrub: washing or disinfection	Little or no changes in resident flora	Reduction of resident flora with active components to prevent bacterial regrowth; cumulative efficacy established for chlorhexidine

NOTE. Table is adapted from [3].

sirable, because it may alter the resident flora, a flora that is considered important for the concept of “colonization resistance” [5].

Resident flora. These are microorganisms that can be persistently isolated from the skin of most persons. These microorganisms are considered permanent residents of the skin. The pathogenicity of resident flora is low, and infections with these bacteria usually require some physical alteration of the host immunity, such as placement of an implant or any foreign body. Hand hygiene can decrease the microbial density of these bacteria, but these bacteria cannot be fully removed by mechanical friction.

This clinical classification is based on the normal skin of an HCW. Bacteria rarely found on normal human skin may become very common if chronic dermatologic diseases are present or if the skin has been damaged. Therefore, this classification incorporates considerable overlap but has been used in most textbooks and guidelines [3, 13, 15].

Plain (nonantimicrobial) soap. This classification comprises detergent-based cleansers for physical removal of dirt and contaminating microorganisms.

Antimicrobial soap. This is a soap containing an ingredient with in vitro and in vivo activity against skin flora.

Hand hygiene. Hand hygiene may be defined as any method that removes or destroys microorganisms on hands.

Hand washing. This is defined as a vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water. Hand washing suspends microorganisms and mechanically removes them by rinsing with water. The fundamental principle is removal and not killing [13].

Hand washing with antimicrobial-containing products (hand antiseptics). This mechanically removes and kills (or inhibits the growth of) microorganisms by means of a medicated soap. This process is often referred to as the chemical removal of microorganisms [1]. This term is also called hand antiseptics, according to the APIC [13].

Hand rub with a waterless alcohol-based compound. A hand rub is a waterless alcohol-based compound [16] (e.g., ethanol, n-propanol, or isopropanol) that is used as a rub or rinse for hands. This type of hand hygiene is fundamentally different from the washing procedures. Approximately 3 mL of the al-

coholic compound is taken from a dispenser onto dry hands and rubbed in for 30 s or until the alcohol evaporates. Microorganisms are killed by the disinfectant and not physically removed as observed with hand washing. Microorganisms not in direct contact with the alcohol will not be affected.

These agents do not remove soil or organic material. Therefore, the hand rub is not an option if hands are visibly soiled. No water and sink are necessary—only the disinfectant dispenser, which is easily mounted at locations of patient care. A simple recipe includes isopropanol and 1%–4% glycerin. Some commercial products include additional disinfectants, such as chlorhexidine or a quaternary ammonium compound, to delay regrowth of bacteria after hand rubbing. These agents are used mainly in operating suites, where a long-term effect is desirable to prevent rapid bacterial regrowth under the gloved hand.

Hand rubs are predominantly applied from a dispenser that provides the correct dose, usually ≥ 3 mL. Some institutions prefer to use small, handy containers that can be carried around in the pockets. However, this approach requires space in the pocket and a leak-proof container with a tight lid. Improperly closed lids may cause leaking or the evaporation of alcohol. In addition, the volume used by the HCW is determined by “eyeballing” rather than by means of a calibrated dispenser that dispenses a well-defined volume when the lever is pressed.

The “European Norm 1500” describes the standard by which a hand disinfectant must demonstrate efficacy before it can be marketed in Europe [17]. The compound should be as effective as propan-2-ol 60% (vol/vol), the reference alcohol (the product fails to meet the requirement if it is statistically less effective). None of the hand-washing procedures with medicated soaps demonstrate equal antimicrobial efficacy and fail to pass this test. Therefore, the test procedure for the hand wash has been adapted in a separate European Norm. Most commercial products include components, such as perfume, color, and emollients to limit dryness of the skin and to improve acceptability by HCWs. Companies do not publish these details of their products but have tested them for antimicrobial activity with all ingredients. Therefore, interaction of the alcohol with the other compounds are not of concern. Moreover, their emollients can even enhance activity by postponing evaporation of the alcohol and increase exposure time.

Hygienic hand wash or hand rub. The aim of a hygienic hand wash or hand rub is to remove (wash) or kill (rub) transient bacteria to prevent cross-transmission by contaminated hands of HCWs. The resident flora basically remains unharmed.

Surgical scrub (wash) or surgical hand rub. The purpose of surgical scrub is to remove and/or kill transient organisms and to reduce resident flora for the duration of a surgical procedure. The goal is to prevent patient-wound contamination by microorganisms present on the hands of the surgical staff. Even microorganisms with low pathogenicity may trigger infections, especially in implant surgery. Therefore, the antimicrobial effect of the surgical scrub or rub should delay regrowth under the gloved hand.

Why Switch from Hand Wash to Hand Rub?

Compliance with hand washing versus hand-rub use. The main drawback of hand washing is the fact that compliance rarely exceeds 40% in the situations in which hand washing is deemed necessary (table 2) [18–25]. Guidelines by the CDC [1] and APIC [13], as well as other organizations, clearly defined the situations in which use of a hand wash or hand rub is considered necessary (see above). The past 20 years have not shown a trend toward improved compliance. Some studies were able to demonstrate a short-term effect but frequently failed to show a sustained effect. Even most recent studies failed to improve hand hygiene by promoting hand washing.

However, compliance improved significantly by switching from hand washing to use of a hand rub [18, 19]. Compliance with hand hygiene procedures improved mainly by introducing the hand rub into the hospital, but not by a similar promotion program for hand washing [19]. Similar results were observed in Europe [19] and in the United States [18]. Therefore, the hand rub may be crucial to improvement of compliance. The shorter time required for use of the hand rub may explain the enhanced compliance.

Antimicrobial efficacy of hand washing and hand rubbing. The CDC has recommended hand washing for hand hygiene for decades [1]. It states that “plain soap should be used for hand washing unless otherwise indicated.” Hand washing for 15 seconds achieves a microbial killing of 0.6–1.1 log₁₀ (1.8–2.8 log₁₀ in 30 seconds) [3]. However, hand washing for <10 seconds is common in clinical practice [26]. Therefore, hand washing with plain soap may fail to remove all transient microorganisms when contamination is heavy. The use of soap and water for frequent daily hand washing can result in minimal reduction or even in an increase in bacterial yield over baseline counts of clean hands [27].

In 1980, Ojajarvi [28] demonstrated that hand washing did not always remove *S. aureus* and other patient-borne bacteria from the hands. In a study by Ehrenkranz and Alfonso [29], hand washing with bland soap failed to prevent transmission of gram-negative pathogens, but the alcohol in the same ex-

Table 2. Representative publications on compliance with hand washing.

Type of unit	Compliance	Year [reference]
ICU	41%	1981 [20]
	30%–48%	1992 [23]
	36%	1999 [19]
	9%–23%	2000 [18]
Ward/ICU	32%	1989 [21]
	48%	1999 [19]
Pediatric	37%	1991 [22]
Surgical ICU	38%	1994 [24]
All ICUs	32%	1994 [25]

NOTE. ICU, intensive care unit.

periment did. Another clinical study indicates that hand washing with a medicated soap was insufficient to completely eradicate methicillin-resistant *S. aureus* on the hands of all nurses [30]. Therefore, there is some evidence that hand washing is not always sufficient to prevent cross-transmission of pathogens. Alcoholic compounds used as hand rub kill 3.2–5.8 log₁₀ cfu, compared with the 1.8–2.8 log₁₀ cfu in 30 seconds removed with medicated soap [3, 31]. Hand rubs are also highly effective against mycobacteria, the bacteria most resistant against any disinfection process [32]. Multiple in vitro studies and in vivo experiments indicate significantly better killing with hand disinfectants than with hand washing [33]. These conclusions have been validated in a randomized crossover clinical trial of pre-operative hand scrubs [34].

Indirect evidence has been generated from an outbreak investigation. A large fungal outbreak was traced to a contaminated skin lotion that nurses applied to their patients with bare hands. Cultures of specimens from the HCWs' hands (*n* = 365) were performed by use of the bag-broth technique during the outbreak (this technique was also used by Doebbeling et al. [12]); none yielded *Paecilomyces lilacinus*. Hand-rub use was the standard procedure for hand hygiene in this hospital [35], which indicates that the hand rub was consistently able to remove several-log cfu of *P. lilacinus*. A randomized clinical trial clearly demonstrated the superior antimicrobial efficacy of hand rubbing versus hand washing [36]. A recent well-balanced review from the United States also favored the use of a hand rub for hand hygiene before invasive procedures [2].

One important clinical study did not favor the use of alcohol compounds. Infections in a surgical intensive-care unit were lowered significantly by the use of a chlorhexidine soap, compared with an alcohol compound [23]. However, HCWs did not favor the alcoholic compound; they only applied 46% of the volume compared with the amount of chlorhexidine soap. Therefore, one may question the results, because this study may have compared compliance and dosage rather than antimicrobial efficacy [37].

Transmission of viruses (e.g., rotavirus) is of concern in pediatric hospitals, as is transmission of other viruses in bone marrow transplantation units. Hand washing and hand rubbing show differing activity against viruses, but washing is generally

less effective than the use of a hand rub [38]. Hand rubs with isopropanol are generally more effective against small and/or nonlipid viruses [39] but have limited efficacy against small viruses, such as poliovirus or rotavirus. The most effective alcohol against viruses is ethanol (>95%), which has been demonstrated to kill $3.2 \log_{10}$ cfu of test organisms (poliovirus) [40]. However, the flash point of pure ethanol is low. Such a product is commercially available in Europe, but experience with it has been very limited. Some hand rubs include a quaternary ammonium compound or, for example, chlorhexidine to expand the spectrum of antimicrobial efficacy.

Speed of procedure and compliance. Multiple studies have provided concise evidence that understaffing is a risk factor for nosocomial infections and epidemics [41, 42]. Steps included in a correct hand washing have been recently reviewed [43]. HCWs who want to wash their hands need to (1) go to the sink; (2) let water run a few seconds; (3) wet their hands and wrists with water; (4) take 1 dose of soap, using the elbow or forearm; (5) rub their hands and wrists for 10–15 seconds [13]; (6) rinse their hands and wrists; (7) dry their hands with paper towels gently, without rubbing; (8) use a paper towel to turn off the faucet; and (9) discard the towel without touching the wastebasket [43].

Approximately 1–2 min are required to correctly wash your hands. Some countries, including the United Kingdom, recommend even the removal of watches to further increase the time for hand washing. In contrast, a HCW can take 3 mL of an alcohol compound from a dispenser located conveniently at a patient's bedside, rub it into his hands, and let it dry. Preliminary data from my institution (127 observations) indicate that this procedure requires 18–27 seconds of working time.

In addition, physicians can read a radiograph during the rub, an activity not feasible when hand washing. When a mathematical model was used to estimate the time necessary for hand washing in an ICU, given 100% compliance, it indicated that ~16% of the total nursing time available would be allocated for hand washing only. A switch to use of a hand rub would decrease the necessary time to 26% of that needed for regular hand washing [44]. This model was subsequently tested in a tertiary care center, and similar time-savings were observed [45]. The data from a clinical trial by Pittet et al. [19] proved that even more time is required for hand washing than was estimated in this model. Therefore, HCWs may just not have the time necessary to wash their hands.

In addition to time constraints, sinks are expensive and, unlike disinfectant dispensers, cannot be installed at locations most convenient for the HCWs. Limited accessibility has been shown to be an important risk factor for poor compliance [18]. Therefore, many countries such as Germany, Switzerland, the Netherlands, and most in Scandinavia have replaced hand washing with a hygienic hand rub for many indications for which hand washing was previously the standard of hand hygiene. At my institution, hand rubbing has replaced hand washing in >90% of opportunities, if the hands are not visibly soiled.

An alcohol dispenser is available between all beds and at each nurse's desk, and 2 are at each intensive care bed.

Potential for recontamination by water or soap. Rinsing with water completes hand washing with soap. The faucet must be turned off, a procedure frequently done with the unprotected washed hands. Therefore, the washed hands might become recontaminated from the faucet or by splashes from the trap or sink. In addition, tap water sometimes is not of drinking-water quality because of contamination of the aerators and peripheral plumbing system. Hence, recontamination with waterborne bacteria after hand washing is a concern, which is supported by several descriptions of outbreaks associated with aerators [46, 47]. HCWs' recontamination of their hands from faucet handles was observed recently during a *Shigella* outbreak [48]. In addition, soaps may get contaminated during use and trigger an outbreak [49, 50]. A disinfectant dispenser not only reduces water consumption but also eliminates contact with a faucet. Both risk factors—the water faucet with the aerator and the hazard of contamination—are intrinsically excluded by the use of an alcohol hand rub. Spores are not killed by alcohols, but commercial products are kept free of spores by filtration. Nevertheless, dispensers should be cleaned before refilling or, preferably, replaced to eliminate the risk of contamination with *Clostridium difficile* spores.

Side effects. Hand hygiene should balance the 2 goals of protecting the skin with its resident flora and killing the transient flora. Intact skin on HCWs' hands helps to protect both patients and the HCWs from acquiring or transmitting nosocomial pathogens. HCWs with dermatitis are more likely to harbor *S. aureus* and other pathogenic bacteria than are those with healthy skin. Therefore, any recommendations for hand washing or hand rubbing should include some advice for skin care, such as making a skin-care product available free for HCWs. Hand washing dries out the skin, and lipid replenishment takes >3 h, whereas alcohol compounds only redistribute lipids. However, either strategy can result in dryness of the skin if no skin-care product is regularly applied.

At my institution, a 1000-bed tertiary care center, a database of >3500 HCWs generated over >10 years did not identify a single case of documented allergy to the commercial alcohol compound in use, which resulted in an estimated incidence density <1:35,000 person-years. Allergies against alcohol are unknown but may be caused by emollients and other compounds added to the alcohol. However, it is prudent to have an alternative hand rub available to HCWs who do not tolerate the standard product.

Issues in the clinical setting. Several important issues have to be considered if an institution switches from hand washing to use of a hand rub with an alcohol compound. The manufacturer of a commercial product that is being considered must provide data on in vitro and in vivo efficacy, as well as data on side effects and letters of recommendation from other institutions. Table 3 summarizes the advantages of hand rubs

Table 3. Comparison of hand washing agents and alcohol-compound hand rubs.

Characteristic	Soap	Medicated soap (e.g., chlorhexidine)	Alcohol compound
Removal of debris	Yes	Yes	No
Killing of transient bacteria in vitro	Good	Very good	Excellent
Elimination of bacteria in vivo	Good	Good	Excellent
Estimated time for procedure	1–2 min	1–2 min	30 sec
Cost	Very low	Low	Very low
Working possible during procedure	No	No	Yes, in part
Risk for recontamination by water/faucet	Yes	Yes	No
Risk for contamination of soap/hand rub	Yes	Yes	No
Accessibility	Limited by sinks	Limited by sinks	Unlimited
Location	At sink	At sink	Anywhere, at bedside and/or door
Compliance >40%	Rare	Rare	Likely, promising, but limited data
Towel needed to dry hands	Yes	Yes	No
Side effects on skin	Very rare	Rare	Very rare
Maintenance cost (water, head, plumbing)	Moderate	Moderate	Low
Flammable	No	No	Yes; risk depends on flash point of product

over hand washing. Other relevant issues for HCWs may include the product's odor and color. Some commercial alcoholic rub-ins may change the color of fingernails, resulting in poor acceptability and compliance by HCWs. In addition, the supplier of the alcoholic rub-in should provide teaching materials and support.

A ward may be chosen for the introduction of alcohol compounds in a pilot phase. The dispenser should deliver a defined amount of alcohol, with narrow margins of variability. In addition, it should not allow evaporation of the alcohol over time. A very recent study demonstrated that evaporation led to a decrease of the volume of alcohol >20% over 28 days with poor dispensers, compared with <1% with good dispensers [51].

A simple training session for HCWs should be held with the introduction of the hand rub. The technique of hand rubbing is simple but crucial. The alcohol kills bacteria only where it comes in contact with the skin. Therefore, use of a lower-than-recommended amount may result in insufficient killing of microorganisms, and this may explain in part the results of the study by Doebbeling et al. [23]. At my facility, equipment has been developed that uses ultraviolet light and a monitor to detect missed areas. After the hands are rubbed with an alcohol product supplemented with a fluorescent dye, the hands are placed into a box with ultraviolet light, and a video camera visualizes the parts of the hands that have had optimal contact with the hand rub. This equipment is anticipated to improve the hand-rubbing technique and may enhance compliance. Commercial products have been developed on the basis of this idea.

A change from washing to rubbing with alcohol should be planned for summer, when dryness of the skin is of less importance. HCWs may mistakenly believe that side effects related to the timing of the switch have been caused by the alcohol rub. Such a change will challenge an infection control team, because unexpected problems—unrelated to alcohol but related to the change—will certainly occur. Hand washing might be regarded in part as a ritual, and a hand rub or rinse cannot

fulfill such expectations of HCWs. Therefore, it is crucial that the heads of the departments support the switch from washing to a rubbing method. Scientific data may not be sufficient to convince all HCWs to switch, but the time-savings are most important for physicians.

Absolute ethanol is flammable at room temperature. Flash points of common alcohols are as follows: ethanol, 12°C; isopropanol, 13°C; n-propanol, 15°C; and commercial products, 21°C–24°C. The incidence of fires due to hand rubs is extremely low in European countries, but there are no published data yet. A questionnaire sent to infection control practitioners in Switzerland did not reveal a single incident in the past 5 years. However, one should know the flash point of the product that is in use. A clearly visible label can prevent any potential fires that may be triggered by negligent use.

This simple, inexpensive recipe for a generic hand disinfectant is based on the Swiss pharmacopoeia: ethanolum ketonatum, 96% vol/vol and 67.60 g; aqua purificata, 17.35 g; and glycerolum, 85% vol/vol and 1.45 g.

Spores should be eliminated by filtration or by adding H₂O₂ 0.125%. This may be an option for developing countries or institutions where an alcohol rub-in can be produced under good manufacturing practice (GMP). Unfortunately, similar recipes are not included in the British or United States pharmacopoeia.

When is a hand rub not an option for hand hygiene? A hand rub does not remove debris and dirt. Therefore, a hand rub is not an option if hands are visibly soiled or contaminated with proteins or organic matter. Hand washing before and after working hours is also recommended.

In conclusion, scientific evidence and ease of use support the use of a hand rub for routine hand hygiene. It is microbiologically more effective in vitro and in vivo, it saves time, and preliminary data demonstrate better compliance than with hand washing. In most countries of Northern Europe, use of a hand rub is the standard for hand hygiene, except when the hands are visibly soiled. Side effects are rare and are mainly related

to dryness of the skin. Therefore, it is an excellent alternative to hand washing when antimicrobial efficacy, time for the procedure, and limited access to sinks are of concern.

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